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TCAD numerical simulation of irradiated thin Low-Gain Avalanche Diodes

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In this work the results of Technology-CAD (TCAD) device-level simulations of non-irradiated and irradiated Low-Gain Avalanche Diode (LGAD) detectors will be presented, aiming at evaluating the effects of layout and technological parameters on the device performance. LGADs are becoming one of the most promising devices for high performance in harsh operating environment thanks to the compensation of the radiation damage effects by exploiting the controlled charge multiplication in silicon after heavy irradiation. State-of-the-art Synopsys Sentaurus TCAD tools have been adopted to have a predictive insight into the electrical behavior and the charge collection properties of the LGAD detectors up to the highest particle fluences expected in the future HEP experiments. To this purpose, the updated "University of Perugia TCAD radiation damage model" has been adopted [1]. By coupling this numerical model, which allows to consider the comprehensive bulk and surface damage effects, with an analytical model that describes the mechanism of acceptor removal in the multiplication layer [2], it has been possible to reproduce experimental data [3] with high accuracy, demonstrating the reliability of the simulation framework. The good agreement obtained between simulation results and measurement data allows us to apply the new developed model not only for the prediction of the behavior, but also for the optimization of the new thin LGAD detectors fabrication run at the Fondazione Bruno Kessler (FBK) facility.

[1] D. Passeri, A. Morozzi, "TCAD radiation damage model", AIDA-2020-D7.4 report (2019)
[2] M. Ferrero et al., "Radiation resistant LGAD design", Nucl. Inst. and Meth. in Phys. Res. A (2019)
[3] V. Sola et al., "First FBK production of 50 μm ultra-fast silicon detectors", Nucl. Inst. and Meth. In Phys. Res. A (2019)

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